METHODS AND APPARATUS FOR CLEANING AN IC ENCAPSULATION SYSTEM

Field of the Invention

The present invention relates to methods for encapsulating leadframe items which each have a leadframe and an IC wired to it. The invention further relates to leadframe encapsulation systems employing the methods.

Background of the Invention

Increasingly, plastics materials such as epoxy-moulding compounds (EMC) are used for encapsulating leadframe items to form IC packages. The leadframe item is located in a mould, a pellet of plastics material is provided for the mould and the plastics material is moulded around the leadframe item, in particular such that the wires become encased in the plastic material.

The use of EMC and the trend towards environmentally friendly compound formulation has given rise to increased levels of pellet dust, leading to various problems including increased mould flash after the encapsulation and disadvantageous movement of the wires ("leads").

Summary of the Invention

The present invention aims to provide a new and useful method for encapsulating leadframe items.

The invention further aims to provide a new and useful system for encapsulating leadframe items.

In general terms, the present invention proposes that dust of the plastics material is removed from the encapsulation system, and in particular from those items where dust principally accumulates and/or where dust is most

disadvantageous. The dust is typically brushed off, or transported out of the system by an air flow, e.g. to a filter.

Typically, these items are the dispenser which dispenses plastics material pellets into the mould, the holder which holds pellets before they enter the dispenser, the conveyor which transports the leadframe items into the moulding region, and the moulds themselves.

Furthermore, to reduce the level of dust which enters the moulding region, the present invention proposes that the path along which the leadframe items are conveyed to the moulding region is closed at times when it is not required to convey leadframe items to the moulding region.

Furthermore, the present invention proposes that leadframe items are conveyed to the moulding region under a cover including a pressure source, so that the dust is continually sucked (or in some embodiments blown) away from the leadframe items.

The invention may be expressed as methods for encapsulating leadframe items which include the above cleaning concepts. Alternatively, the invention can be expressed as a leadframe encapsulation system which employs the methods.

Brief description of the Figures

An embodiment of the invention will now be described for the sake of example only with reference to the following figures in which:

Figure 1 is a view of a pellet holder and pellet dispenser in a known encapsulation system;

Figure 2, which is composed of Figures 2(a) and 2(b), shows how in the embodiment the pellet holder is cleaned;

Figure 3 is a view of the pellet dispenser in relation to the onloader which carries it in a known encapsulation system;

Figure 4, which is composed of Figures 4(a) and 4(b), shows cleaning of the pellet dispenser by the embodiment;

Figure 5 illustrates the relative positions of a leadframe input region, turntable region, pellet input region and moulding region, and conveyance of leadframe items to a moulding region of the embodiment;

Figure 6 illustrates motions of a door for closing the input module of the embodiment;

Figure 7 illustrates transportation of leadframe items by the embodiment;

Figure 8 illustrates vacuum cleaning of a mould brush in the embodiment; and

Figure 9 is a view illustrating cleaning of moulds by the mould brushes in the embodiment.

Detailed Description of the Embodiment

Referring firstly to figure 1, a side (horizontal) view of a part of a known encapsulation system is shown. Pellet holder 1 is for transmitting pellets of a plastics material such as EMC to a pellet dispenser 2. As discussed below, the pellet holder 1 is movable in a vertical direction towards or away from the pellet dispenser 2. It includes a number of holes 3 through which pellets of EMC are pushed into corresponding holes 4 in the pellet dispenser 2. Pellets are pushed from the holes 3 by rods (not shown) moving within the pellet holder 1. The rods rise to push the pellets into the holes 4 and then descend, but before the pellets fall out of the holes 4, a shutter plate (not shown) closes the lower end of the holes 4 so that the pellets are retained in the dispenser 2. During the process a significant amount of EMC dust is generated or released.

Figure 2 shows two views of the pellet holder 1. Figure 2(a) is a top view vertically downward. In figure 2(b) the pellet holder 1 is seen from the direction of figure 1, the "front" of the system. The pellet holder 1 is supported by an apparatus 7 arranged to reciprocate the pellet holder 1 in the vertical direction. Whereas in figure 1 the pellet holder 1 is raised to an upper position so as to contact the lower portion of the pellet dispenser 2, as shown in figure 2(b) the pellet holder 1 is in the lowered position.

Figure 2(a) shows the shapes of the holes 3 in the upper surface 5 of the pellet holder 1. Figure 2(a) also shows a cleaning device 9 for cleaning the pellet holder 1. The cleaning device 9 has an air cylinder 11 having a horizontal axis marked as 12 in figure 2(a). Below the air cylinder 11 is vertically downward facing surface 13 provided with bristles 14 constituting a brush. The downwardly directed bristles 14 are for brushing the upwardly facing surface 5 of the pellet holder 1. Before this can be achieved the cleaning device 9 is moved horizontally (to the right in figures 2(a) and 2(b)) from a first position on the left of figure 2(b), to the right into the other position shown in figure 2(b), where the bristles 14 of the brush contact the upper surface 5 of the pellet holder 1.

The cleaning device 9 includes an internal conduit 15 connected via the air cylinder 11 to a vacuum source. The conduit has an end near the bristles 14. Thus, the vacuum source 15 acts to remove dust from the surface 5 of the pellet holder 1, and also to remove any dust which has accumulated on the bristles 14 of the brush.

Figure 3 shows how in a known encapsulation system the pellet dispenser 2 is supported in a fixed positional relationship to an onloader 20 which, as discussed below, has the function of transporting leadframe items to a moulding region in which the packages are formed. Figure 3 is a side view (i.e. from a horizontal direction but perpendicular to the view of figure 2(b)).

Referring to figure 4, the encapsulation system includes a further cleaning device 21 for cleaning the lower surface of the pellet dispenser 2. The cleaning device 21 includes a brush 23 which can be raised to contact the lower surface of the pellet dispenser 2 or lowered away from the lowest surface of the pellet dispenser 2. As with the cleaning device 9, an internal conduit 25 opening proximate the brush 23 leads to a vacuum source, so that dust from the surface of the pellet dispenser 2 is not retained on the brush 23 but removed from the system.

Figure 4(b) shows the mechanism 27 for driving the cleaning device 21. The cleaning device 21 is arranged to rotate about a vertical axis 24 and is driven by a rotary motor 26, which is connected to the cleaning device 21 by a belt 28. The cleaning device 21 is raised to or lowered from the pellet dispenser 2 by a piston cylinder 29.

Turning to figure 5, an input mechanism is shown by which leadframe items 31 are brought into a moulding region 32. The leadframe items are transported to a leadframe input region 33 in direction A, and a conveyor (not shown but of a conventional form) brings leadframe items 31 into turntable region 38 where there is located a turntable 35 which rotates in a horizontal plane (the plane of figure 5) to correctly orientate the leadframe items 31. The leadframe input region 33 and turntable region 38 may be accessed by operators via one or more front access doors 34, 42, that are normally closed during operation of the system. The front access doors 34, 42 may comprise swing-doors and may be pivotally arranged with the compartments housing the respective regions 33, 38, such that the front access doors 34, 42 are conveniently opened for access to the regions.

The onloader 20 carrying the pellet dispenser 2 is reciprocated by a mechanism (not shown) horizontally between a position at the top of figure 5 in the pellet loading region 39 and a second position marked as 36 in the turntable region 38. In this second position, the onloader 20 overlies the turntable 35 and picks up the leadframe items 31 located there. The turntable region 38 and pellet loading region 39 are separated by a door 37 which is

opened when it is desired to move the onloader 20 over the turntable 35, or when it is desired to return the onloader 20 to the pellet loading region 39. From the pellet loading region 39, the onloader 20 transports the leadframe items 31 and pellets to region 32' and finally to moulding region 32 utilizing guide tracks arranged in the respective regions 39, 32'.

Figure 6 is a front view of the arrangement of figure 5, looking from the bottom of figure 5 along section B-B. The upper and lower positions of the door 37 are marked respectively as 37a and 37b. A piston cylinder 40 with a vertical axis is provided for reciprocating the door 37 between these two positions.

Turning to figure 7, the mechanism is shown by which a leadframe item 31 having a substrate 41 and a die 43 is transported by the onloader 20. The onloader 20 has fingers 45 for gripping the edges of the substrate 41 and the grip is ensured by a leadframe location pin 47 that locates a corresponding hole on the substrate 41 indicating its orientation. A cover 49 is provided having a recess 50 on its lower side for receiving the die 43, while the outer portion of the lower surface of the cover 49 presses against the upper surface of the substrate 41. A spring loaded mechanism (not shown) continuously urges the cover 49 against the substrate 41. The recess 50 in the cover 49 is in communication with a conduit 51 leading to a vacuum source. Thus a vacuum environment is maintained between the cover 49 and the substrate 41, and any dust particles are sucked towards a vacuum source. Note that an alternative to providing a vacuum source would be to connect the conduit 51 to an air source, so that it would continually blow air into the recess 50, and thus blow any dust out of the region 50. While this alternative is practicable providing that the air has a laminar flow, it is not preferred since the dust is merely displaced to other portions of the embodiment.

Figure 8 is a view of the moulding region 32 of the embodiment system from the front direction (i.e. parallel to figure 6), while figure 9 shows the same region from the side direction (i.e. direction C of figure 8). The moulding region 32 includes a bottom mould 60 and a top mould 61. The onloader 20 is provided with mould brushes 62, 63 which respectively have brushes

pointing downwards and upwards for respectively brushing the horizontal surfaces of the bottom mould 60 and the top mould 61.

When the onloader 20 is in the position shown in figure 9, the brushes 62, 63 are in the region 32' on the right of figure 9. In the location the brushes 62, 63 are in "normal" unextended position in which they are inward from the surfaces of the top and bottom moulds 61, 60, but the brushes are then moved to an "extended" position in which the free ends of the brushes 62, 63 are in horizontal register with the horizontal surfaces of the respective moulds 60, 61. As the onloader 20 moves to the left to be fully inside the region 32 so that the leadframe items are between the top and bottom moulds 60, 61, the brushes 62, 63 brush the surfaces of the top and bottom moulds 60, 61, and finally come fully into register with cleaning devices 64, 65 which are respectively fixed to the bottom and top moulds 60, 61 at their position furthest from the region 32'. In figure 9, the brushes 62, 63 are shown again in this position, at the leftmost end of their travel.

The cleaning devices 64, 65 include respective vacuum channels 66, 67 leading to vacuum sources, and thus the insides of the cleaning devices 64, 65 are at low pressure. When the cleaning devices are close to the brushes 62, 63 they suck dust away from them and out of the system (e.g. to a filter).

When the onloader 20 once more moves back to the right, the brushes 62, 63 once more pass over and brush the surfaces of the bottom and top moulds 60, 61 respectively.

The brushes 62, 63 and the cleaning devices 64, 65 reduce the amount of dust which remains on the mould surfaces when the moulding is carried out. This in turn reduces the risk of flashes on the leads, or shifting of the leads during the encapsulation process.

Although a single embodiment of the invention has been described in detail here, many variations are possible as will be clear to a skilled reader. For

example, not all of the various cleaning devices described above are used in all embodiments of the invention.